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The managing plan for abrasion in coastal area of Garut Regency

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Abstract

The area of Garut is located in the southern part of West Java and directly connects to the Indian Ocean. Due to large coastal area of about 73.25 kms, it is susceptible to the impacts of abrasion due to strong waves, high tides, and human activities. This research aims to contrive a managing plan for abrasion control in coastal area of Garut Regency during September to November 2012 that includes, compiling recorded documents of the existing condition to predict the changes of coastal pattern as well as determining priorities for sustainable coastal developments by establishing intersectional programs in order to optimize the operational projects in coastal areas. To support the research, the data are divided into, first, primary data that include physical and social facts and Figures of socio-economic, oceanographic, and meteorological conditions. The second ones, the secondary data, consist of scientific-driven environmental and geographical information, such as visual map of Indonesia, Landsat TM images, (GLOVIS), basic map from the local government, sea level rise (TOPEX/POSEIDON JASON1, JASON2), sea wave, and wind (BMKG), and legal materials, such as policies and regulations, as well as institutions. Analysis on the data is conducted to determine the biological conditions of the waters, to identify changes in sea surface and in coastal lines, and to formulate an abrasion modelling. The results show that abrasion and accretion occur in different levels and indicates that ecosystem plays an important role in controlling the abrasion, particularly in the areas where the mangrove ecosystem is located. The impacts from abrasion are more due to natural factors than human activities. Therefore, it is suggested that an integrated management in the form synchronization programs with related institutions is initiated and developed a series of schemes that become priorities for the local development.

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Keywords: abrasion; accretion; coastal area; Garut Regency; managing plan.

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1. Introduction

Having coastline of about 73.25 kms, the Garut Regency coastal area, located in the southern part of West Java and situated closely to the Indian Ocean, is vulnerable to the environmental degradation due to both human activities [1] and natural phenomena [2]. Coastal areas have been known for their vulnerability to the impacts of abrasion caused mainly by powerful currents [3] and high tides [4]. The type of current causing abrasion is the longshore current that carries high-potential risks, and the tide in the south coast may reach four meter height. In addition, coastal areas are also the place where the land has been developed for and converted to housings, infrastructural establishments, as well as fishing and farming businesses. In order to overcome this abrasion problem in Garut, it is important to start a planning for coastal management. In this regard, it is suggested that the local government to implement policies in developing the area's potentials.

This research, aims to compile bio-historical documents containing the previous and current conditions and predictions of coastal patterns. It is also to determine priorities in the sustainable developments of the coastal area by planning inter-sectoral programs to optimize the area's potentials of maintaining environmental sustainability and human activities.

2. Method

Research was conducted in September-November 2012 in Garut Regency, West Java (Fig..1). Primary data were collected by conducting research measurement previously determined from secondary study and initial analysis results. Secondary data consist of institutional data, questionnaire statistics report, and literary research. Primary data include socio-economic facts and oceanographic and meteorological Figures (coastal characteristics, currents, tides, tidal waves, winds, and coastlines), while secondary data range from visual map of Indonesia, Landsat Thematic Mapper images (GLOVIS), basic map from the Garut Regency's government sea level rise (TOPEX/POSEIDON JASON1, JASON2), sea waves (http://ecmwf.int/), winds (BMKG), to policies, regulations and institutions. The data are analyzed to determine the environmental conditions of the waters, changes in sea level rise and in coastline (radiometric correction, geometric correction, cutting image, masking), and abrasion modelling.

Modelling is conducted using softwares Sea-Surface Modelling System (SMS) and MIKE21 with Generalized Model for simulating shoreline (GENESIS) method, a numeric modelling system designed for performing simulation for change in coastline. This enables prediction for longshore transport rate and change in coastline caused by sediment transport with or without coastal security structure in particular period of time.

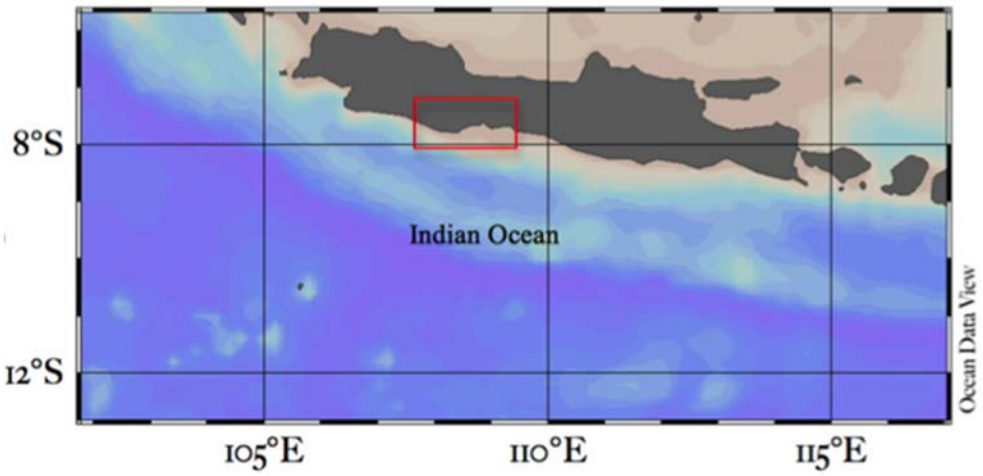

Fig. 1. Research location [5]

3. Results and Analysis

3.1. Condition and abrasion pattern in Garut Regency

In Garut, abrasion and accretion occured in the same time during nineteen years period. Based on pattern observation, show that there are three areas affected by the accretion and six more areas suffered from abrasion. It is counted that there are six abrasion points and three accretion points in districts of Caringin, Bungbulang, Mekarmukti, and Cibalong. Table 1 depicts distances of coastline declines and strides in 1994-2013.

Table 1. Depicts distances of coastline declines and strides in 1994-2013.

Transect location	Transposition distance's shoreline in 19 years (m)	Average transposition distance's shoreline (m/years)	Error rate (%)
Caringin District	68,24	-3,59	5 %
Caringin District	116,20	-6,11	5 %
Bungbulang District	118,92	-6,26	5 %
Mekarmukti District	102.83	-5.41	5 %
Pakenjeng District	92.6	+4.87	5 %
Cikelet District	225.81	+11.88	5 %
Pamengpeuk District	94,73	+4,98	5 %
Cibalong District	140,27	-7,38	5 %
Cibalong District	162,14	-8,53	5 %

One of the assumptions proposed for the abrasion major correction is that the difference in topographic height in 1994 would be considered the same as that in 2013 [6, 7]. In addition, based on the results of tidal wave modelling system, it is accumulated the average of difference for 0.05 meter between the images and modelling results. Below is the description of abrasion pattern correction for each district (Fig. 2).

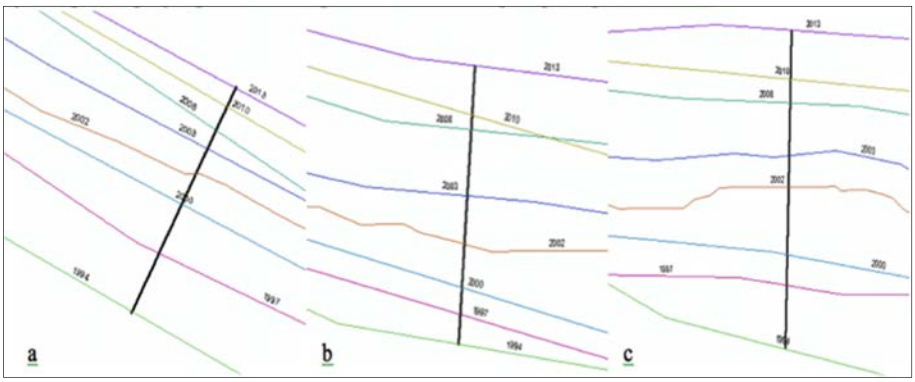

Fig. 2. Transposition of coastline at (a) Mekarmukti, (b) Cibalong, (c) Sancang [6]

- Caringin district

In Caringin District there was two areas affected by abrasion, there was Cidamar (Fig. 3) and Purbayani Villages. Purbayani village suffered more severe abrasion to reach the shoreline setback of 6.11 m/year and only 3.59 m/year in Cidamar Village. Distance setback shoreline in Cidamar Village in 1994-2013 was 68.24 - 8 meters, which is 60.74 meters (3.19 m/year).

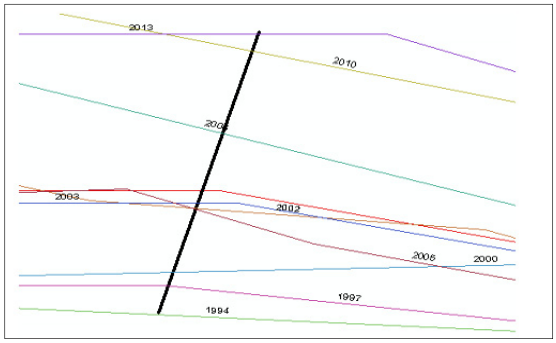

Fig. 3. Transposition of coastline at Cidamar Village, Caringin District

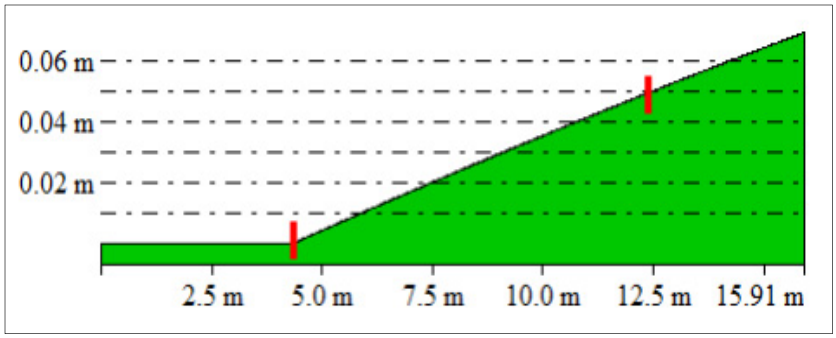

Fig. 4. Coastal topographic at Cidamar Village, Caringin District

In Fig. 5 a pattern of abrasion in Purbayani Village the setback distance along 116.20 meters. With the same correction with Cidamar Village, the end result is 116.2 - 19 meters, which is 97.2 meters long or become 5.11 m/year.

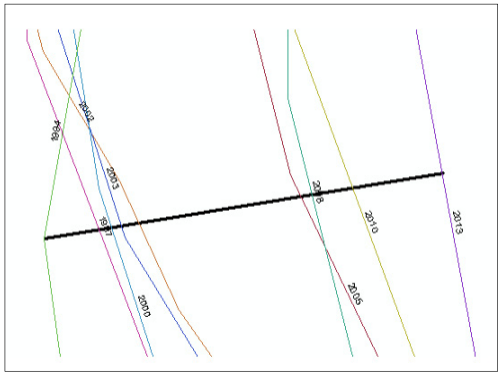

Fig. 5. Transposition of coastline at Purbayani Village, Caringin District

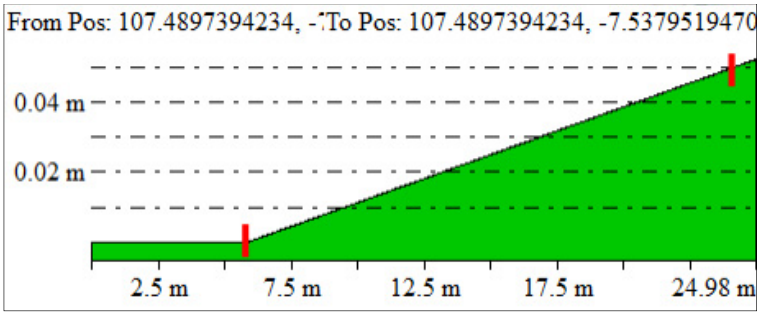

Fig. 6. Coastal topographic at Purbayani Village, Caringin District

- Bungbulang district

Abrasion in Bungbulang District almost same as Purbayani Village, Caringin District. Within 19 years, the movement of the shoreline setbacks along the 118.92 meters or 6.26 m / year. However, these results was still sourced from the digitization of satellite image.

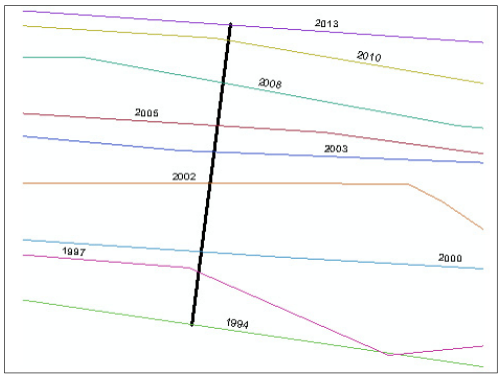

Fig. 7. Transposition of coastline at Sinarjaya Village, Bungbulang District

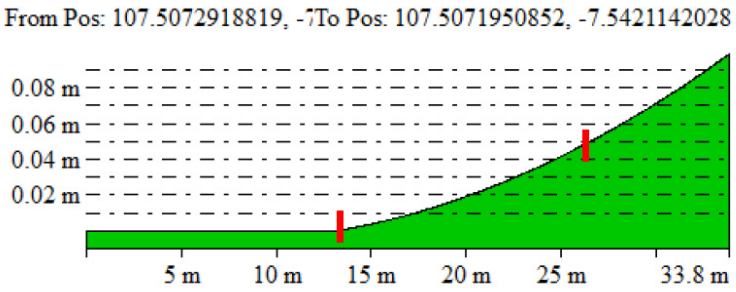

Fig. 8. Coastal Topographic at Sinarjaya Village Bungbulang District

- Mekarmukti district

Abrasion in Mekarmukti District (Fig. 9) was almost same as the two previous districts within 19 years, the movement of the shoreline setbacks along the 102.83 meters or 5.41 m/year.

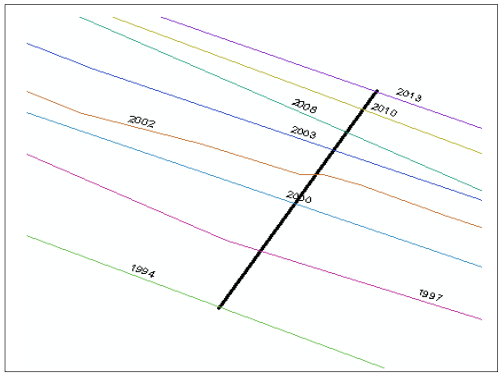

Fig. 9. Transposition of coastline at Cijayana Village, Mekarmukti

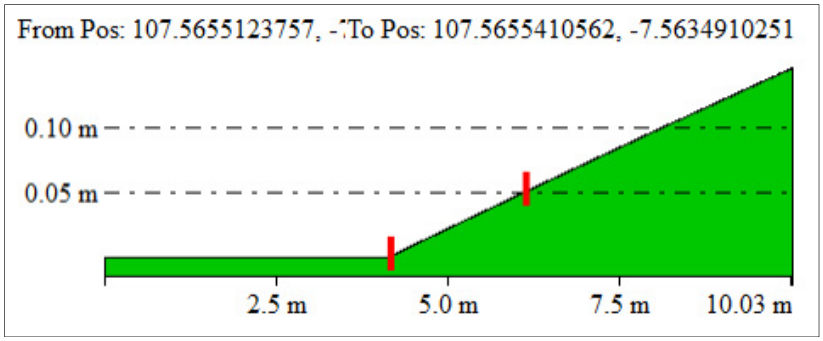

Fig. 10. Coastal topographic at Cijayana Village, Mekarmukti District

- Cibalong district

The level of abrasion in this district are at two points, there was in Karyasari and Sancang. In both villages have higher abrasion patterns compared to other villages in Garut. Shoreline setbacks per year to reach 7.38 meters and 8.53 meters. These results have not been corrected by the tide. It is necessary to look at the topography of the coast that is in Fig. 11.

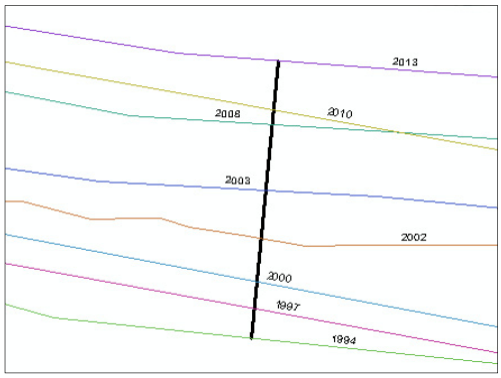

Fig. 11. Transposition of coastline at Karyasari Village, Cibalong District

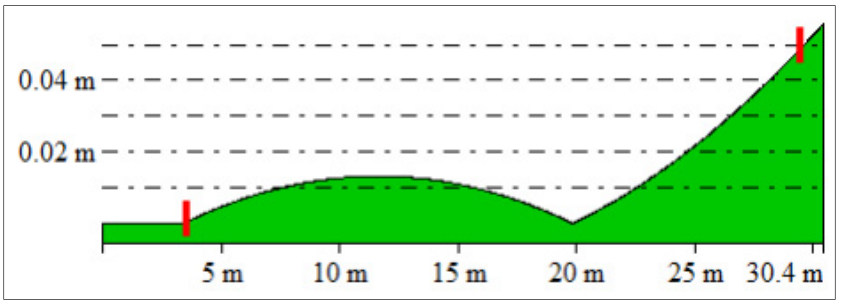

Fig. 12. Coastal topographic at Karyasari Village, Cibalong District

3.2. Factors affecting abrasion in Garut Regency

- Synchronization with sea level rise

One of the factors leading to abrasion is the rise in sea level occurring both globally and locally. Globally, the sea level rise reaches to 2.8 to 3.6 mms per year or in twenty years, the rise is up to 56 to 72 mms [8]. Areas with highly sloping coastal topography are predicted to suffer from significant coastline declines. Correlation between the coastline movement and sea level rise every image selecting year is analyzed with Pearson's correlation.

Table 2. Pearson's correlation between coastline movement and sea level rise

Transect Location	R value	Description
Caringin District	0.792	Strong positive relationship
Caringin District	0.600	Medium positive relationship
Bungbulang District	0.351	Weak positive relationship
Mekarmukti District	0.120	Very weak positive relationship
Cibalong District	0.71	Strong positive relationship
Cibalong District	0.763	Strong positive relationship

- Synchronization with waves

Based on the results from satellite imagery capture (NOAA Wavewatch III), waves in the coastal area of Garut Regency are considerably higher during the eastern season than those in the western season. On the other hand, Caringin's waters have the lowest waves compared to the other districts in Garut both in the western and eastern seasons. The wave height based on the satellite images in Caringin ranges from 1.76 to 1.80 meters (western season) and from 1.6 to 2.2 meters (eastern season).

- Synchronization with currents

Garut Regency has two contrasting current patterns in both seasons. The patterns are predictable: during the western season, they move towards the west, while in the eastern season, they head to the same direction. Current direction aligned to the coastline is identified as coastline current. This results in abrasion caused by the condition of the local currents in several areas. It also leads to the establishment of accretion areas in the middle parts of Garut Regency, in the districts of Pakenjeng, Cikelet, and Pameungpeuk.

- Synchronization with human activities

In order to identify the relation between human activities and abrasion in the coastal areas of Garut Regency, a sampling technique is selected in the points where the abrasion occurs. Field observation suggests that there have been changes in the land use in several points of the areas functioning [9] as conservation, including Mount Mandalawangi and Sancang Forest. Conservation areas are significantly dominant in Garut and this leads to the sharp increase of erosion level and land crisis and also alarming impacts on the downstream area.

4. Conclusion

Observation and data analysis suggest the following concluding points regarding to abrasion:
Abrasion and accretion in Garut Regency are proven to occur in different levels and different areas. In addition, the affected areas also show each own distinctive characteristics. Analysis on physical and biological Figures of Garut Regency indicates that ecosystem plays an important role in abrasion management, particularly in the areas of existing ecosystem.

1. Natural factors flash higher domination in abrasion impacts compared to human activities; however, it is predicted that this would have the similar effects in long period of time.
2. It is suggested that a synchronizing program is issued in several institutions in order to realizing schemes and priorities for the local developments.

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